IR-2 NON-ROUTEINE RIGGING PROCEDURE and JOB HAZARD ANALYSIS FOR REMOVAL/REINSTALLATION of BACKWARD END PLUG, LEAD HORSESHOE and DIRC MAGNETIC SHIELD CYLINDER

1.0 Loads:
- BWD End Plug: 16,500 lbs
- Lead Horseshoe: 1630 lbs
- DIRC Magnetic Shield Cylinder/Lead Liner: 13400 lbs
- Rail Extension Support Structure: 680 lbs
- Rail Extension: 210 lbs

2.0 Install Support Structures and Rail Extensions:

2.1 Notify the Safety Officer, Sandy Pierson x2686 (page 650-424-7654), or Frank O’Neill x5300, that the backward end plug removal is about to commence.

2.2 Notify Stan Ecklund x3182 (page 650-424-7229) that the backward end plug will be removed. Stan will need to remove the PEP wire alignment components that are located on the Q2, Q4L and the Q5L. Also the alignment wire will need to be slackened to allow the DIRC magnetic shield cylinder, the lead horseshoe and the backward end plug to be extracted.

2.3 Complete overhead crane checklist AP-350-990-17.

2.4 The crane operator shall maintain control of the radio control crane control box at all times during this operation. There is a spare control box. This box shall be stored in the mechanical operations cabinet with the padlock secured.

2.5 Magnetic field from BaBar superconducting solenoid shall be zero with power supply locked out and administrative interlock switch opened with key removed. The administrative key lock switch is located on the lower north wall in the detector area to the east of the chicane opening (see Figure 1). The key is stored in the key box in room 201 on the second floor of Building 621.

2.6 Disconnect the interlock cable (located in front of the plastic cover, (see Figure 2) from the switch box located on white shield cylinder end flange. Wind cable and store on floor adjacent to PEP Backward Raft.

2.7 Remove the plastic cover that prevents access to the DIRC tunnel. This cover is attached to the DIRC Shield Cylinder lead liner using four .75-10UNC grade 5 socket head cap screws x 1.5” long with flat washers. These bolts are removed using a 5/8” hex key.

2.8 Remove the .75-10UNC ASTM A325 hex head special bolt x 4” long, flat washer and thick washer, that is located behind the east turnbuckle on the inner circle of the lower DIRC magnetic shield cylinder. (see Figure 2)
2.9 Install two turnbuckles between cylinder flange and the elephant ear support structures located on PEP pier face. These turnbuckles provide a load path for the weight of the plug/lead/cylinder if the BWD end doors are opened. The turnbuckles are permanently connected to the lower DIRC magnetic shield cylinder flange. The turnbuckles are then connected to brackets fastened to the elephant ear brackets using a .75 diameter shoulder screw x 4” long and 5/8-11UNC hex nut at each connection (see Figure 3). The shoulder screw is tightened hand tight with a 3/8” hex key. The turnbuckles are adjusted to provide an upward force on the lower DIRC magnetic shield cylinder to level the backward end plug rail system. However, all ten of the inner bolts on the lower DIRC magnetic shield cylinder flange will need to be removed to allow vertical adjustment of the rail extension. Adjust the load on the turnbuckles as necessary using a 1.5” open end wrench. Clockwise rotation (as seen from above) shortens the turnbuckle. Counterclockwise rotation (as seen from above) extends the turnbuckle.
2.10 Install two Crosby® Style G-209, Stock number 1018516, 6.5-ton capacity screw pin anchor shackles on one of the two green rail extension support structures that are located on the floor in the northwest corner of the detector area.

2.11 Install a LiftAll® Tuff-Edge number EN-801T web sling of 3200 lb minimum vertical capacity in a “choke” configuration on each shackle.

2.12 Lower the 10-ton hoist and slip the slings over the hook. (see *Figure 4 for the rigging configuration*).

![Figure 4. Rigging the West Green Rail Extension Support Structure](image)

2.13 The load is resting beyond the north travel of the 10-ton hoist. Gently raise the 10-ton hoist but hold the load to prevent swinging. Once the load can hang plumb, slowly raise the 10-ton hoist and position the green rail extension support structure on the appropriate elephant ear structure.

2.14 Bolt the green rail extension support structure to the elephant ear structure using six 1.25 -7UNC ASTM A325 bolts x 4.5” long with hardened flat washers and hex nuts on each structure. The hex nuts are tightened to approximately 100 lb-ft using a 2” box wrench.

2.15 Remove the web slings and screw pin anchor shackles from the green rail support structure and remove the slings from the crane hook.

2.16 Reposition the crane over the remaining green support structure in the northwest corner of the detector area.
2.17 Install two Crosby® Style G-209, Stock number 1018516, 6.5-ton capacity screw pin anchor shackles on the remaining green rail extension support structure that is located on the floor in the northwest corner of the detector area.

2.18 Install a LiftAll® Tuff-Edge number EN-801T web sling of 3200 lb minimum vertical capacity in a “choke” configuration on each shackle.

2.19 Lower the 10-ton hoist and slip the slings over the hook. (see Figure 4 for the rigging configuration)

2.20 The load is resting beyond the north travel of the 10-ton hoist. Gently raise the 10-ton hoist but hold the load to prevent swinging. Once the load can hang plumb, slowly raise the 10-ton hoist and position the green rail extension support structure on the appropriate elephant ear structure.

2.21 Bolt the green rail extension support structure to the elephant ear structure using six 1.25-7UNC ASTM A325 bolts x 4.5” long with hardened flat washers and hex nuts on each structure. The hex nuts are tightened to approximately 100 lb-ft using a 2” box wrench.

2.22 Remove the web slings and screw pin anchor shackles from the green rail support structure and remove the slings from the crane hook.

2.23 Sammy is shown in Figure 5.

2.24 Install two LiftAll® Tuff-Edge number EN-801T web slings of 3200 lb minimum vertical capacity in a choker type connection around one of the rail extensions that are lying on the floor in the northwest corner of the detector area. Use edge protectors to prevent cutting the slings. (see Figure 6)

2.25 Lower the 10-ton hoist and slip the slings over the hook.

2.26 The load is resting beyond the north travel of the 10-ton hoist. Gently raise the 10-ton hoist but hold the load to prevent swinging. Once the load can hang plumb, slowly raise the 10-ton hoist and position rail extension on the appropriate green support structure.

2.27 Manually raise the north end of the rail extension and remove the sling and edge protectors. Lower the rail extension.
2.28 The rail extension bolts to the permanent rails using two \( \frac{3}{4}-10\) UNC Hex head Cap screws x 2.5” long, grade 5. These bolts shall be torqued to hand tight.

2.29 Reposition the crane over the remaining rail extension in the northwest corner of the detector area.

2.30 Install a LiftAll® Tuff-Edge number EN-801T web sling of 3200 lb minimum vertical capacity in a choker type connection around the rail extension that is left lying on the floor in the northwest corner of the detector area. Use edge protectors to prevent cutting the sling.

2.31 Lower the 10-ton hoist and slip the slings over the hook.

2.32 The load is resting beyond the north travel of the 10-ton hoist. Gently raise the 10-ton hoist but hold the load to prevent swinging. Once the load can hang plumb, slowly raise the 10-ton hoist and position rail extension on the appropriate green support structure.

2.33 Manually raise the north end of the rail extension and remove the sling and edge protectors. Lower the rail extension.

2.34 The rail extension bolts to the permanent rails using two \( \frac{3}{4}-10\) UNC Hex head Cap screws x 2.5” long, grade 5. These bolts shall be torqued to hand tight.

3.0 Remove DIRC Magnetic Shield Cylinder:

3.1 Unbolt the outer row of sixteen .75-10UNC ASTM A325 hex head special bolts x 4” long, flat washer and thick washer, on the white DIRC magnetic shield cylinder. This cylinder has an 18,000 pound preload on it so these bolts must be backed out in steps approximately one half turn each per side until the preload is removed. The bolts are removed using a 1.25” hex, ¾” drive, socket wrench.

3.2 Remove all of the \( \frac{3}{4}” \) bolts from the outer row on the white cylinder.

3.3 The PEP alignment wire components must be removed before proceeding. See procedure 2.2.

3.4 The white cylinder is on rollers. Manually extract the white cylinder until it clears the DIRC tunnel opening. Be certain not to extract to the point where the cylinder can roll off of the end of the rail extensions. Caution: There is a crushing/amputation hazard between the white cylinder and the Q5 PEP magnet.

3.5 Remove the four 1.75-5UNC set screws from the top surface of the white cylinder.

3.6 Place two arch spacers (see Figure 7), north and south, and install four custom engineered Crosby® 1.75-UNC swivel hoist rings through the holes in the arch spacers into the set screw threaded holes in the white shield cylinder. These swivel hoist rings are rated for 24,000 lb in any direction. Torque the swivel hoist rings to approximately 100 lb-ft using a 1.25” hex key. This small amount of torque is based on the soft structure of the magnetic steel used in the fabrication of the DIRC magnetic shield cylinder.

3.7 Position the 50-ton hoist directly over the center of the four swivel hoist rings. The hoist hook shall be open on the west side.

3.8 Lower the 50-ton hoist and place the eyes of a 6-ft long LiftAll® Tuflex number EE120 eye and eye roundsling of 10,600 lb minimum vertical capacity over the hoist hook.

3.9 Repeat step 3.7 with three additional 6-ft long LiftAll® Tuflex number EE120 eye and eye roundslings of 10,600 lb minimum vertical capacity over the hoist hook. The hook should be oriented so that the sling eyes are inline adjacent to one another east to west.
3.10 The lower end of the east outer sling shall be “basket” connected to the northeast swivel hoist ring using a Crosby® Style G-209, Stock number 1018614, 17-ton capacity screw pin anchor shackle. (See Figure 8)
3.11 The lower end of the east inner sling shall be “basket” connected to the southeast swivel hoist ring using a Crosby® Style G-209, Stock number 1018552, 9.5-ton capacity screw pin anchor shackle and a Crosby® Style G-209, Stock number 1018516, 6.5-ton capacity screw pin anchor shackle in series. (See Figures 7 & 8)

3.12 The lower end of the west inner sling shall be “basket” connected to the southwest swivel hoist ring using a Crosby® Style G-209, Stock number 1018598, 13.5-ton capacity screw pin anchor shackle. (See Figure 9)
3.13 The lower end of the west outer sling shall be “basket” connected to the northwest swivel hoist ring using a Crosby® Style G-209, Stock number 1018570, 12-ton capacity screw pin anchor shackle. (see Figure 9) The different sized screw pin anchor shackles are used to balance the load and aid ease of installation.

3.14 Slowly raise the white cylinder using the 50-ton hoist on “Creep” mode. The cylinder will rise first on the north end approximately two inches before the south end. There are cam followers on the bottom east surface of this cylinder. These cam followers must clear the slots in the rail extensions before any side (east or west) movement may commence. Clearances are very tight in this area. Avoid any contact between the cylinder and the PEP beamline components.

3.15 Do not drop load on personnel.

3.16 Park the load directly over the IR-2 shield wall. Turn off the crane control box until the crane operator repositions himself in the assembly area.

3.17 Take to IR-2 assembly area. Avoid transporting the load over the BaBar Electronics House. Be certain that all personnel are clear of the load path. Lower slowly onto four 4” x 4” minimum dunnage.

4.0 Remove Lead Horseshoe:

4.1 Using the ¾” drill motor, extract the plug/horseshoe assembly until the horseshoe clears the DIRC tunnel opening. (see Figure 10) Clockwise extracts, counter-clockwise inserts. The lead horseshoe is cantilevered from the backward surface of the end plug using four .75-10UNC socket head cap screws x 2.5” long, grade 5 with flat washers.

Figure 10. ¾” Drill Motor
4.2 The two ends of a LiftAll® Tuff-Edge number EN-801T web sling of 3200 lb minimum vertical capacity is connected to one of the two lift holes on the horseshoe using a Crosby® Style G-209, Stock number 1018491, 4.75-ton capacity screw pin anchor shackle.

4.3 The two ends of another LiftAll® Tuff-Edge number EN-801T web sling of 3200 lb minimum vertical capacity is connected to the other lift hole on the horseshoe using a Crosby® Style G-209, Stock number 1018491, 4.75-ton capacity screw pin anchor shackle.

4.4 Lower the 10-ton hoist and slip the web slings over the crane hook in a basket type orientation. The rigging hardware for this operation is never altered and is stored in the northwest corner of the detector hall. (see Figure 11)

4.5 Gently lift on the 10-ton hoist to take most of the weight of the horseshoe (approximately 1630 pounds).

4.6 Unbolt the horseshoe from the back surface of the end plug using a 5/8” hex key. Lift the horseshoe slowly using the 10-ton hoist.

4.7 Do not drop load on personnel.

4.8 Park the load directly over the IR-2 shield wall. Turn off the crane control box until the crane operator repositions himself in the assembly area.
4.9 Take to the IR-2 assembly area. Avoid transporting the load over the BaBar Electronics House. Be certain that all personnel are clear of load path. Lower slowly onto the floor.

5.0 Remove Backward End Plug:

5.1 Using the ¾” drill motor, a 6-point hex socket ¾” drive and three 12” lg ¾” drive extensions in series (see Figure 10), extract the backward end plug until it clears the DIRC tunnel opening. Clockwise extracts, counter-clockwise inserts. Be careful not to extract the plug so far that it collides with the PEP Q5 magnet. Also, there is a potential amputation hazard between the end plug and the Q5 magnet. It may be necessary to push the plastic cover that covers the Q4 north end connections out of the way as the plug is extracted. Beware: this is a potential finger crushing area.

5.2 Connect the four special purpose lift pads (see Figure 12) to the end plug using a total of sixteen 7/8-9UNC socket head cap screw x 2.5” long, grade 8. Be certain that the curvature of the lift pad matches the curvature of the end plug. Torque the 7/8” bolts to 100 lb-ft.

5.3 THIS STEP SHOULD BE COMPLETE AFTER THE INITIAL USE OF THIS EQUIPMENT. Install four 15,000 lb capacity swivel hoist rings to the lift pads. Torque each swivel hoist ring to 470 lb-ft.

5.4 Position the 50-ton hoist directly over the center of the four swivel hoist rings. The hoist hook shall be open on the west side.

5.5 Lower the 50-ton hoist and place the eyes of a 6-ft long LiftAll® Tuflex number EE120 eye and eye roundsling of 10,600 lb minimum vertical capacity over the hoist hook.

5.6 Repeat step 3.7 with three additional 6-ft long LiftAll® Tuflex number EE120 eye and eye roundslings of 10,600 lb minimum vertical capacity over the hoist hook. The hook should be oriented so that the sling eyes are inline adjacent to one another east to west.

5.7 The lower end of the east outer sling shall be “basket” connected to the northeast swivel hoist ring using a Crosby® Style G-209, Stock number 1018516, 6.5-ton capacity screw pin anchor shackle. (See Figure 13)

5.8 The lower end of the east inner sling shall be “basket” connected to the southeast swivel hoist ring using a Crosby® Style G-209, Stock number 1018552, 13.5-ton capacity screw pin anchor shackle. (See Figure 13)

5.9 The lower end of the west inner sling shall be “basket” connected to the southwest swivel hoist ring using a Crosby® Style G-209, Stock number 1018552, 13.5-ton capacity screw pin anchor shackle. (See Figure 13)
5.10 The lower end of the west outer sling shall be “basket” connected to the northwest swivel hoist ring using a Crosby® Style G-209, Stock number 1018516, 6.5-ton capacity screw pin anchor shackle. (see Figure 13) The different sized screw pin anchor shackles are used to balance the load and aid ease of installation. 

5.11 Slowly raise the end plug using the 50-ton hoist on “Creep” mode.

5.12 Do not drop load on personnel.

5.13 Park the load directly over the IR-2 shield wall. Turn off the crane control box until the crane operator repositions himself in the assembly area.

5.14 Take to IR-2 assembly area. Avoid transporting the load over the BaBar Electronics House. Be certain that all personnel are clear of load path. Lower slowly onto four 4” x 4” minimum dunnage.

6.0 Install Backward End Plug:

6.1 Notify Joe Kenny x3517 (page 650-570-8742) that there will be an access to the confined space.

6.2 Notify the Safety Officer, Sandy Pierson x2686 (page 650-424-7654), or Frank O’Neill x5300, that the installation is about to commence.
6.3 Notify Stan Ecklund x3182 (page 650-424-7229) that the backward end plug will be installed. Stan will need to install the PEP wire alignment components that are located on the Q2L, Q4L and the Q5L PEP magnets.

6.4 After the DIRC tunnel has been approved for entry, inspect area for loose debris, magnetic items and potential interferences with the backward end plug. A “Go/No Go” gauge is provided for both the east and west sides (see Figure 14). These gauges should be slid along the rails to demonstrate that the end plug stops will not interfere during the installation.

6.5 The green rail support structures and rail extensions should have been installed during the removal process. It is not customary to remove these items after the end plug removal process is complete unless the plug is expected remain out for a period longer than 7 calendar days (earthquake requirement). If these items are not in place, they must be reinstalled (see Section 2.0).

6.6 Complete overhead crane checklist AP-350-990-17.

6.7 The crane operator shall maintain control of the radio control crane control box at all times during this operation. There is a spare control box. This box shall be stored in the mechanical operations cabinet with the padlock secured.

6.8 THIS STEP SHOULD ALREADY BE COMPLETE FROM THE REMOVAL PROCESS. Connect the four special purpose lift pads (see Figure 12) to the end plug.
using a total of sixteen 7/8-9UNC socket head cap screw x 2.5” long, grade 8. Be certain that the curvature of the lift pad matches the curvature of the end plug. Torque the 7/8” bolts to 100 lb-ft.

6.9 THIS STEP SHOULD ALREADY BE COMPLETE FROM THE REMOVAL PROCESS. Install four 15,000 lb capacity swivel hoist rings to the lift pads. Torque each swivel hoist ring to 470 lb-ft.

6.10 Position the 50-ton hoist directly over the center of the four swivel hoist rings. The hoist hook shall be open on the west side.

6.11 Lower the 50-ton hoist and place the eyes of a 6-ft long LiftAll® Tuflex number EE120 eye and eye roundsling of 10,600 lb minimum vertical capacity over the hoist hook.

6.12 Repeat step 3.7 with three additional 6-ft long LiftAll® Tuflex number EE120 eye and eye roundslings of 10,600 lb minimum vertical capacity over the hoist hook. The hook should be oriented so that the sling eyes are in line adjacent to one another east to west.

6.13 The lower end of the east outer sling shall be “basket” connected to the northeast swivel hoist ring using a Crosby® Style G-209, Stock number 1018516, 6.5-ton capacity screw pin anchor shackle. (See Figure 13)

6.14 The lower end of the east inner sling shall be “basket” connected to the southeast swivel hoist ring using a Crosby® Style G-209, Stock number 1018552, 13.5-ton capacity screw pin anchor shackle. (See Figure 13)

6.15 The lower end of the west inner sling shall be “basket” connected to the southwest swivel hoist ring using a Crosby® Style G-209, Stock number 1018552, 13.5-ton capacity screw pin anchor shackle. (See Figure 13)

6.16 The lower end of the west outer sling shall be “basket” connected to the northwest swivel hoist ring using a Crosby® Style G-209, Stock number 1018516, 6.5-ton capacity screw pin anchor shackle. (see Figure 13) The different sized screw pin anchor shackles are used to balance the load and aid ease of installation.

6.17 Slowly raise the end plug using the 50-ton hoist.

6.18 Do not drop load on personnel.

6.19 Park the load directly over the IR-2 shield wall. Avoid transporting the load over the BaBar Electronics House. Be certain that all personnel are clear of load path. Turn off the crane control box until the crane operator repositions himself in the detector area.

6.20 Using the crane bridge and trolley, position the end plug directly over the rail extensions.

6.21 Slowly lower the 50-ton hoist until the end plug is approximately one inch above the rail extensions. Caution: there is an risk of crushing fingers or toes and amputation of same during this process.

6.22 Switch the crane control box to “creep” mode.

6.23 Lower the end plug onto the rail extensions using the 50-ton hoist. Be certain that the tow ball enters the receptacle on the southwest corner of the plug and also that the cam followers enter the rail groove on the east rail extension.

6.24 Using a ¾” drive, 1.25” socket wrench, test to make sure that the drive screw will move the end plug.

6.25 Remove the slings from the 50-ton hoist.

6.26 Raise the 50-ton hoist hook out of the way.

6.27 Disconnect the screw pin shackles at the swivel hoist ring.

6.28 Remove the four special purpose lift pads. Leave the swivel hoist rings attached to the lift pads.

6.29 Store the special purpose lift pads with swivel hoist rings in the northwest corner of IR-2 hall in the detector area.
6.30 Using the ¾” drill motor, a 6-point hex socket ¾” drive and three 12” lg ¾” drive extensions in series (see Figure 10), insert the backward end plug far enough to ensure that 18” minimum space is provided between the north surface of the end plug and the south surface of Q5L. Clockwise extracts, counter-clockwise inserts. Be careful not to extract the plug into the PEP Q5 magnet by mistake. Also, there is a potential amputation/crush hazard between the end plug and the Q5 magnet.

7.0 **Install Lead Horseshoe:**

7.1 The two ends of a LiftAll® Tuff-Edge number EN-801T web sling of 3200 lb minimum vertical capacity is connected to one of the two lift holes on the horseshoe using a Crosby® Style G-209, Stock number 1018491, 4.75-ton capacity screw pin anchor shackle.

7.2 The two ends of another LiftAll® Tuff-Edge number EN-801T web sling of 3200 lb minimum vertical capacity is connected to the other lift hole on the horseshoe using a Crosby® Style G-209, Stock number 1018491, 4.75-ton capacity screw pin anchor shackle.

7.3 Lower the 10-ton hoist and slip the web slings over the crane hook in a basket type orientation. The rigging hardware for this operation is never altered and is stored in the northwest corner of the detector hall. (see Figure 11)

7.4 Gently raise the 10-ton hoist.

7.5 Do not drop load on personnel.

7.6 Park the load directly over the IR-2 shield wall. Avoid transporting the load over the BaBar Electronics House. Be certain that all personnel are clear of load path. Turn off the crane control box until the crane operator repositions himself in the detector area.

7.7 Using the crane bridge and trolley, position the horseshoe directly over the rail extensions and immediately to the north of the backward end plug.

7.8 Lower the 10-ton hoist until the four mounting holes in the horseshoe match the corresponding threaded holes in the backward end plug.

7.9 Bolt the horseshoe to the back surface of the end plug using four .75-10UNC socket head cap screws x 2.5” long, grade 5 with flat washers. Tighten these bolts to 50 lb-ft using a 5/8” hex key.

7.10 Lower the 10-ton hoist and remove the slings from the hook.

7.11 Remove the two screw pin anchor shackles and store the sling with shackles attached in the northwest corner of IR-2 hall in the detector area.

7.12 Using the ¾” drill motor (see Figure 10), insert the plug/horseshoe assembly completely. Slow the insertion as the final resting position is approached.

7.13 Stan Ecklund will need to install the PEP wire alignment components that are located on the Q2L, Q4L and the Q5L at this time. This will take approximately 45 minutes to 1 hour.

8.0 **Install DIRC Magnetic Shield Cylinder:**

8.1 THIS STEP SHOULD ALREADY BE COMPLETE FROM THE REMOVAL PROCESS. Remove the four 1.75-5UNC set screws from the top surface of the white cylinder. Place two arch spacers (see Figure 7), north and south, and install four custom engineered Crosby® 1.75-UNC swivel hoist rings through the holes in the arch spacers into the set screw threaded holes in the white shield cylinder. These swivel hoist rings are rated for 20,000 lb in any direction. Torque the swivel hoist rings to approximately
100 lb-ft using a 1.25” hex key. This small amount of torque is based on the soft structure of the magnetic steel used in the fabrication of the DIRC magnetic shield cylinder.

8.2 Position the 50-ton hoist directly over the center of the four swivel hoist rings. The hoist hook shall be open on the west side.

8.3 Lower the 50-ton hoist and place the eyes of a 6-ft long LiftAll® Tuflex number EE120 eye and eye roundsling of 10,600 lb minimum vertical capacity over the hoist hook.

8.4 Repeat step 3.7 with three additional 6-ft long LiftAll® Tuflex number EE120 eye and eye roundslings of 10,600 lb minimum vertical capacity over the hoist hook. The hook should be oriented so that the sling eyes are inline adjacent to one another east to west.

8.5 The lower end of the east outer sling shall be “basket” connected to the northeast swivel hoist ring using a Crosby® Style G-209, Stock number 1018614, 17-ton capacity screw pin anchor shackle. (See Figure 8)

8.6 The lower end of the east inner sling shall be “basket” connected to the southeast swivel hoist ring using a Crosby® Style G-209, Stock number 1018552, 9.5-ton capacity screw pin anchor shackle and a Crosby® Style G-209, Stock number 1018516, 6.5-ton capacity screw pin anchor shackle in series. (See Figures 7 & 8)

8.7 The lower end of the west inner sling shall be “basket” connected to the southwest swivel hoist ring using a Crosby® Style G-209, Stock number 1018598, 13.5-ton capacity screw pin anchor shackle. (See Figure 9)

8.8 The lower end of the west outer sling shall be “basket” connected to the northwest swivel hoist ring using a Crosby® Style G-209, Stock number 1018570, 12-ton capacity screw pin anchor shackle. (see Figure 9) The different sized screw pin anchor shackles are used to balance the load and aid ease of installation.

8.9 Slowly raise the white cylinder using the 50-ton hoist.

8.10 Do not drop load on personnel.

8.11 Park the load directly over the IR-2 shield wall. Avoid transporting the load over the BaBar Electronics House. Be certain that all personnel are clear of load path. Turn off the crane control box until the crane operator repositions himself in the detector area.

8.12 Using the crane bridge and trolley, position the DIRC shield cylinder directly over the rail extensions and immediately to the north of the DIRC Standoff Box.

8.13 Slowly lower the white cylinder using the 50-ton hoist on “Creep” mode. There are cam followers on the bottom east surface of this cylinder. These cam followers must be inserted in the slots in the east rail extension. Clearances are very tight in this area. Avoid any contact between the cylinder and the DIRC and the PEP beamline components. Caution: keep fingers and toes clear of load. There is an amputation/crush hazard during this operation.

8.14 After the cylinder is lowered completely onto the rail extensions and the slings are somewhat slack, check to see if the cylinder is free to roll on the rail extensions.

8.15 Remove the slings from the 50-ton hoist hook.

8.16 Raise the 50-ton hoist hook up to the bridge.

8.17 Disconnect the screw pin anchor shackles from the swivel hoist rings.

8.18 Remove the four swivel hoist rings and two arch spacers. Be careful – the arch spacers are free to slide. Store all rigging components in the northwest corner of the detector area in IR-2.

8.19 The white cylinder is inserted manually. Push the cylinder until it comes in contact with the spring loaded plungers located on the horseshoe. A “clunk” may be heard indicating that the end plug is seated against the stops.
8.20 Bolt the outer row of sixteen .75-10UNC ASTM A325 hex head special bolts x 4” long, flat washer and thick washer, on the white DIRC magnetic shield cylinder. This cylinder has an 18,000 pound preload on it so these bolts must be inserted in steps approximately one half turn each per side until the preload is attained and the cylinder flange is flush with the white end door housing. The bolts are installed using a 1.25” hex, ¾” drive, socket wrench.

9.0 Remove Rail Extensions and Support Structures:

9.1 Remove the east rail extension bolts using a 1.25” hex box or socket wrench. These bolts should only be hand tight.

9.2 Manually raise the north end of the rail extension and slide two LiftAll® Tuff-Edge number EN-801T web slings of 3200 lb minimum vertical capacity and edge protectors under the rail. Connect the slings in a “choke” condition. Lower the rail extension.

9.3 Lower the 10-ton hoist and slip the slings over the hook.

9.4 Gently raise the 10-ton hoist until the rail extension is above the PEP beamline components. (see Figure 6)

9.5 Transport the rail extension to the northwest corner of the detector area and lower to the floor. As the load nears the floor, manually push the rail extension as far north as possible to park the extension out of the path of foot traffic. Be careful not to allow the load to swing.

9.6 Remove the slings from the 10-ton hoist hook.

9.7 Raise the 10-ton hoist and reposition directly over the west rail extension.

9.8 Remove the west rail extension bolts using a 1.25” hex box or socket wrench. These bolts should only be hand tight.

9.9 Manually raise the north end of the rail extension and slide two LiftAll® Tuff-Edge number EN-801T web slings of 3200 lb minimum vertical capacity and edge protectors under the rail. Connect the slings in a “choke” condition. Lower the rail extension.

9.10 Lower the 10-ton hoist and slip the slings over the hook.

9.11 Gently raise the 10-ton hoist until the rail extension is above the PEP beamline components. (see Figure 6)

9.12 Transport the rail extension to the northwest corner of the detector area and lower to the floor adjacent to the east rail extension. As the load nears the floor, manually push the rail extension as far north as possible to park the extension out of the path of foot traffic. Be careful not to allow the load to swing.

9.13 Remove the slings from the 10-ton hoist hook.

9.14 Raise the 10-ton hoist and reposition directly over the east green rail extension support structure.

9.15 Unbolt the green support structure from the elephant ear structure. The 1.25” hex nuts are loosened using a 2” box wrench.

9.16 Install two Crosby® Style G-209, Stock number 1018516, 6.5-ton capacity screw pin anchor shackles on the east green rail extension support structure.

9.17 Install a LiftAll® Tuff-Edge number EN-801T web sling of 3200 lb minimum vertical capacity in a “choke” configuration on each shackle.

9.18 Lower the 10-ton hoist and slip the slings over the hook. (see Figure 4 for the rigging configuration)

9.19 Gently raise the 10-ton hoist until the green support structure is above the PEP beamline components.
9.20 Transport the green rail support structure to the northwest corner of the detector area and lower to the floor adjacent to the rail extensions. As the load nears the floor, manually push the rail extension as far north as possible to park the extension out of the path of foot traffic. Be careful not to allow the load to swing.

9.21 Remove the sling from the 10-ton hoist hook.

9.22 Raise the 10-ton hoist and reposition directly over the west green rail extension support structure.

9.23 Unbolt the green support structure from the elephant ear structure. The 1.25” hex nuts are loosened using a 2” box wrench.

9.24 Install two Crosby® Style G-209, Stock number 1018516, 6.5-ton capacity screw pin anchor shackles on the west green rail extension support structure.

9.25 Install a LiftAll® Tuff-Edge number EN-801T web sling of 3200 lb minimum vertical capacity in a “choke” configuration on each shackle.

9.26 Lower the 10-ton hoist and slip the slings over the hook. (see Figure 4 for the rigging configuration)

9.27 Gently raise the 10-ton hoist until the green support structure is above the PEP beamline components.

9.28 Transport the green rail support structure to the northwest corner of the detector area and lower to the floor adjacent to the other rail support structure. As the load nears the floor, manually push the rail extension as far north as possible to park the extension out of the path of foot traffic. Be careful not to allow the load to swing.

9.29 Remove the slings from the 10-ton hoist hook.

9.30 Raise the 10-ton hoist up to the bridge.

9.31 Remove the two turnbuckles at the elephant ear support structures located on the PEP pier face. The turnbuckles are left permanently connected to the lower DIRC magnetic shield cylinder flange. The turnbuckles are disconnected using a 3/8” hex key. Adjust the load on the turnbuckles as necessary using a 1.5” open end wrench. Clockwise rotation (as seen from above) shortens the turnbuckle. Counterclockwise rotation (as seen from above) extends the turnbuckle. Insert the shoulder screws back into the lower brackets to prevent them from being misplaced.

9.32 Install the plastic cover that prevents access to DIRC tunnel. This cover is attached to the DIRC Shield Cylinder lead liner using four .75-10UNC grade 5 socket head cap screws x 1.5” long with flat washers. These bolts are installed using a 5/8” hex key.

9.33 Connect the magnet interlock cable to the switch box located on white shield cylinder end flange.

9.34 The administrative interlock switch (located on north wall adjacent to end door drive main disconnects) is turned “on” using a key. The key is stored in the key box in room 201 on the second floor of Building 621. (see Figure 15 for the final configuration)
10.0 Potential Hazards:

10.1 Typical hoisting and rigging hazards.
10.2 Crushed extremities.
10.3 Amputation.
10.4 Rotating parts.
10.5 Overhead loads.
10.6 Personnel in path of load movement or under load.
10.7 Restrictive work areas.
10.8 Entry into DIRC tunnel (confined space).
10.9 Unexpected load movement.
10.10 Operator error.
10.11 Equipment failure.
10.12 Tripping due to awkward work surfaces.
10.13 Opening between platform and detector.
10.14 Sprain/impact injury due to drill torque or recoil.
10.15 Failure of crane or rigging hardware.
10.16 Back strain and foot crush from heavy rigging gear.
11.0 Hazard Controls:

11.1 Crane Operator shall be a SLAC-certified (EFD) rigger.
11.2 A minimum of two experienced technical support staff is required. An experienced technician is assumed to be an individual that has been involved in the removal and reinstallation of the backward end plug, lead horseshoe and DIRC magnetic shield cylinder a minimum of ten cycles.
11.3 No one will be allowed under a suspended load or in the path of a load.
11.4 Casual observers will not be allowed in the area.
11.5 Strict controls of crane control box and rigging procedures.
11.6 Inspection of equipment prior to use.
11.7 Inspection of crane functions.
11.8 Current training of personnel. Permit required confined space training is required.
11.9 Use of personnel of adequate physical capability and agility for heavy duty rigging applications.
11.10 Crane maintenance current.
11.11 Review of procedures with rigging and technical support personnel.
11.12 Appropriate use of personnel protection equipment.
11.13 Appropriate supervision of tasks.
11.14 Continuous safety oversight is required.
11.15 Continuous engineering oversight is required.
11.16 Continuous supervision of technical support is required.

12.0 Field Observations and Comments:

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13.0 Acknowledgements:

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